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## IPM IN NEW YORK APPLE ORCHARDS - DEVELOPMENT, DEMONSTRATION, AND ADOPTION

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Formal Integrated Pest Management (IPM) projects on apples have been under way in both research and extension in New York since 1972. While the Extension-sponsored demonstration program ended in 1980, we have continued to track the adoption phase of this effort through an exchange of information with apple growers throughout the state. In early 1985, a telephone survey of randomly selected apple growers was conducted throughout New York State to determine the impact of Extension sponsored IPM activities on their pest management practices. This survey was jointly sponsored by USDA- Extension Service as part of the National Impact Study on IPM, and by Cornell Cooperative Extension as part of the New York Impact Study on IPM. Data from that survey indicated that a complete IPM approach was being employed on 8 per cent of the apple acreage in the state, and that portions of the IPM approach were being utilized on 73 percent of the remaining acreage. This significant impact needed to be examined and documented so that other states and provinces could utilize the findings of this study.

This paper attempts to document the development, demonstration, and adoption of (IPM) principles over a 14-year period. It summarizes the results and events associated with each of the three phases. Previous publications have summarized the status of Apple IPM Implementation efforts across North America (13 ), and the early efforts in the New York Apple IPM approach were presented in 1979, (10).

### DEVELOPMENT OF AN APPLE IPM PROGRAM

The development of a truly integrated pest management program is often complex, requiring the linkage of many different activities, practices, and con-

cepts. It requires communication at all levels whether formal or informal. For example, scouting methods and economic or action thresholds are fundamental to every IPM pilot project. Previous authors (7) have detailed the means of arriving at these values. Similar research efforts have been under way in New York utilizing funds provided to the Departments of Entomology and Plant Pathology by the CIPM (Consortium for Integrated Pest Management) Project, USDA competitive grants, Cornell IPM Research grants, and through funds obtained from other sources. Incorporation of the findings of this research into ongoing IPM projects will come to pass only if there are strong linkages among the disciplines and among all the parties who have some role to play in the eventual adoption of the principles. This section will address these developments.

### Action Thresholds

Determination of action thresholds was initially established through meetings and discussions among apple industry personnel, Cornell fruit research and extension faculty, extension agents, and growers. This expert information was then refined through formal research efforts and applied research projects to its present form. Thresholds from neighboring states were often evaluated and some were adjusted to New York conditions and incorporated into our system.

### Scouting Systems

Scouting and sampling systems were developed in much the same way as the action thresholds. Expert teams of entomologists or plant pathologists formulated the initial methods, and formal research projects provided the current recommended system. In 1982, a network of volunteer reporters was established to pro-

vide a daily picture of pest, crop, and weather developments in commercial orchards around the state. This system supplies data on weather, apple scab infection periods, apple tree phenology, and the first occurrence of many insects. It serves as a base for the continuous evaluation of scouting and sampling methods.

### **IPM Practices**

The IPM approach combines the use of biological, chemical, cultural, and other practices to keep pests below economic injury levels. Throughout the course of the program, every effort was made to examine these practices and introduce new knowledge to the growers.

Biological control possibilities were studied in the early years, especially for management of European red mite. Two species of predatory mites were found in New York orchards. One species, *Typhlodromus pyri*, was predominant in western New York, while *Amblyseius fallacis* was predominant in eastern New York. Laboratory and field evaluations of all pesticides used by fruit growers were conducted so that growers could make choices in their spray applications if they wanted to encourage biological control by these species. Parasitic wasps attacking leafrollers and woolly apple aphids were also studied and were able to provide acceptable levels of control under certain conditions.

Several new chemical application practices were introduced during the early years of IPM. One practice was the application of a fungicide during the early part of the season to control apple scab, followed by no additional fungicide applications for a period of six to eight weeks. This was known as the single application technique (SAT). Another practice was the application of insecticides on an alternate row basis. This practice was introduced just prior to the formal pilot program but was considered to be an important IPM technique. Also introduced were pesticide timing methods which incorporated information on the best choice of materials to control certain insects, or the best choice of materials to eradicate established apple scab and powdery mildew infections. In later years, two new disease resistant apple varieties were released from the Cornell fruit breeding program. The 'Liberty' and 'Freedom' varieties (4 and 5) are resistant to all of the major apple diseases and now offer fruit growers a new strategy for combating pests.

### **Educational Efforts**

Meetings with participating extension agents were held 3 to 5 times during each year. Not all meetings were centered on IPM. Specific IPM meetings focused on pest identification, sampling methods, thresholds, and the possible management choices when different pests were present. Other meetings focused on the results of the program effort. Most meetings were held jointly with research and extension faculty who pres-

ented new management approaches, pesticide efficacy results, and plans for applied research.

County or regional grower meetings were held two to three times each year. Some dealt specifically with IPM, while others dealt with the overall production system. Extension faculty and agents usually participated in these meetings. Some meetings addressed the logistics of conducting an IPM program, while others covered pest identification, thresholds, sampling procedures, management choices, and effectiveness of control measures. Chemical fieldmen usually attended these meetings. As grower groups moved toward adoption of IPM principles, they requested assistance in establishing cooperatives and organizations. The IPM Support Group, along with Cornell faculty, held several meetings with these groups to assist them in their organizational efforts.

IPM workshops were held during the winter months at which IPM personnel and research and extension faculty presented in-depth review of pests, the problems they cause, and the best management strategies. Scout training sessions were held several times each year during the growing season to provide in-field training on a weekly basis.

Every two years, IPM personnel participated in extension field days or demonstration days for growers and fieldmen. This afforded them the opportunity to demonstrate the performance of new monitoring devices, new thresholds, new management strategies, and new sampling procedures.

### **Literature and Software Development**

Development of educational literature began with the preparation of orchard checklists for determining when to look for pests. This was followed by the preparation of a series of individual pest fact sheets showing what the pests and their damage looked like, where to check for these pests in the orchard, and how to manage them. Crop protection manuals containing information on all phases of apple production were also developed. More recently a complete scouting manual for Tree Fruit IPM in Western New York has been completed (1). A Crop Management Guide for Tree Fruit has also been prepared (2).

The Extension fruit entomologist actively collaborated with IPM personnel to produce an on-line library of apple and tree fruit insects (5). This computer program was available across the electronic information delivery system, SCAMP (8), to fruit extension agents throughout the state. Users could access the life history, monitoring methods, and management of strategies for 37 insects through computer terminals located in county cooperative extension offices. The Extension fruit pathologist assisted IPM personnel in the development of an on-line diagnostic program (8) to assist fruit extension agents in identifying disease-related fruit and tree injury.

Over the years, the annual *Cornell Recommends* has been slightly modified to include IPM information. Current plans call for a major revision of the present format to offer growers a choice between conventional pest management and integrated pest management. This publication is sold to apple growers in New York through Extension.

Research articles on work directly connected with the IPM program, or on work leading to IPM, have been especially numerous in Entomology. The results of this research are not only used in the New York program, but are usually adopted by neighboring apple-growing states as well.

### **Information Linkages**

Formal information linkages were established through a State Advisory Committee for Integrated Pest Management, formed at the beginning of IPM program, to review progress and discuss future plans. This committee was composed of representatives from state and federal agencies, Cornell departments, and individuals from the private sector. This committee continues to meet at least once every year.

The Apple IPM work group composed of Cornell faculty from four departments, IPM personnel, and extension agents, meets at least once each year to review progress and plan for the future. Several regional apple IPM advisory committees made up of growers, fieldmen, and extension agents meet on an irregular basis.

Annual reports of program activities and impacts have been prepared each year and distributed to the State IPM Advisory Committee, the Cornell Apple IPM work group, and to other interested parties.

Cooperative research has been conducted every year between the IPM program and faculty in the disciplines of Entomology and Plant Pathology. Research projects, on a less frequent basis, have been conducted with faculty in Natural Resources, Pomology, and Agricultural Economics.

Quite often, research and extension faculty were able to acquire grants and contracts as a direct result of their association with the IPM program. Such resources were usually shared. Occasional private grants were made to the IPM program in the form of weather equipment or pesticides.

Informal information linkages were established in many settings, and were often the key to progress. An example of this linkage is illustrated here. In the first eight years of the apple IPM program, IPM personnel were housed on the same floor as the fruit research and extension entomologists, and the faculty in plant pathology were one floor below. This enhanced communication between the IPM field staff and the faculty and resulted in sound strategy development. This housing arrangement was undoubtedly the key to success in the early years. During the first four years of the

program, weekly field meetings with these same individuals took place in the county where the pilot program was under way. Faculty also made themselves available on a 24 hour basis to answer questions and respond to problems. During the 14 years of apple IPM, extension agents have reviewed field situations and strategies with IPM personnel on a daily basis. They telephoned the IPM farm advisors every morning at 5:30 AM to review the types of pest activity seen the previous day, and to discuss different management options. The agents used this information in their morning radio shows and in weekly newsletters.

## **LINKAGE TO THE TEACHING BASE**

### **Internships**

In 1976, the apple IPM program began to offer an internship which provided on-the-job training for individuals interested in a career as a pest management consultant. This effort was initiated because of the interest and needs expressed by the industry for individuals who could provide IPM services. Intern candidates were required to spend eight months working under IPM field personnel in the county where the pilot program was under way. Most of the applicants to this program were college graduates. Financial support initially came from Cooperative Extension, but this support was not available after the second year. In an effort to maintain an on-going intern program, growers, industry, and federal granting agencies were solicited for funds. However, only a small amount of support was generated and that came from agricultural chemical manufacturers. The lack of financial support and the loss of one of the key members of the IPM field staff forced us to abandon the concept after five years of operation.

The IPM program believes that this type of internship is still the best way of educating young people for careers in modern pest management. It is unfortunate that federal granting agencies in particular were unwilling to fund proposals calling for innovative forms of education of this type.

In the seven years of apple IPM demonstration activity, the IPM program was successful in placing all who served as interns, in positions in the apple industry. Some were employed by corporate farms, IPM cooperatives, individual farmers, as extension agents, chemical fieldmen, and as farm managers. Many of these "graduates" now form the backbone of the apple IPM monitoring network. Individuals trained in sound pest and crop management principles are still needed to meet the demand from the private sector.

### **IPM Curriculum**

In the early 70s the departments of Entomology and Plant Pathology created an undergraduate course in Integrated Pest Management titled Insect Pest Man-

agement for Plant Protection. Later the Cornell IPM Steering Committee, working with interested faculty, was able to develop a curriculum for a Masters of Professional Studies (MPS) with specialization in Plant Protection.

This curriculum was designed to provide the skilled field personnel needed to bring IPM concepts to all New York farmers. In addition to a 30 credit hour course requirement, each candidate is required to spend a minimum of one growing season as a trainee in an ongoing IPM program. This formal internship approach now provides some of the experience that growers and industry are looking for in new graduates.

### Cooperation With Other States

The Cornell IPM program has always emphasized cooperation with other states and regions through an exchange of annual reports, and research and extension publications. In the mid 70s, Cornell cooperated with the University of Vermont to help launch its Apple IPM program by sharing sampling methods, thresholds, fact sheets, manuals, equipment, and computer time.

The IPM program also transferred its entire computer software package for our information delivery system, SCAMP, to the University of New Hampshire to help them rapidly assemble and deliver pest, crop, and weather information. The original software was obtained from Michigan State University.

## DEMONSTRATION OF APPLE IPM CONCEPTS

### Pilot Project

A demonstration of IPM concepts took place on 20 commercial apple farms through an Extension pilot program. This project was conducted on 3,000 acres of apples in western New York during the years 1973-1979. The results of these activities are detailed in the publication of Tette, et. al., (10). This demonstration program ended in 1979, and efforts were then directed toward ensuring the adoption of the concepts.

### Economic data

The economics of the New York demonstration effort were examined during 1979 and 1980 by Cornell economists working with data gathered from apple farms in western New York. Their analysis (11,12) indicated that most apple farmers could reduce their crop protection costs by \$26/acre if they utilized the IPM practices of scouting, thresholds, and proper pesticide timing. During that same time period, an economic survey and analysis of fruit growers throughout the Northeast (14) revealed that many areas of the northeast could benefit economically from adoption of IPM programs. The IPM program has continued to evaluate certain economic factors over the course of the 14 years. This information is presented in another publication (3).

## ADOPTION OF IPM PRACTICES BY NEW YORK APPLE GROWERS

### Large Farms

Several large corporate farms were the first to adopt IPM practices by creating full time IPM positions in their organizations. Individuals employed in this manner were expected to monitor and sample for pest problems and were assigned to gather soil and leaf samples for analysis, determine the best dates for harvest; educate and direct pruning crews; review the need for fertilizers, pesticides, machinery, etc.; and work with distributors to solicit bids on fertilizer, pesticides, and machinery. While no measurable economic impacts were gathered by Cornell these farms continue to employ such individuals and encourage them to attend IPM workshops and training schools.

### Small Farms

Small farms (30-300 acres) which wish to have someone provide them with IPM services have been handicapped in their ability to obtain these services because of the lack of private consultants. A number of the small farmers who participated in the Extension pilot program decided to band together in a cooperative and use an acreage fee to generate funds to hire a full-time person. During 1980 and 1981, personnel from the Cornell IPM program, and the Department of Agricultural Economics assisted them in forming the Wayne County Pest Management Cooperative, which was incorporated as a non-profit cooperative conforming to the laws for cooperatives in New York. Their initial year of operation was based upon an acreage fee of \$20/acre for bearing apple orchards, with similar fees for other tree fruit and non-bearing orchard.

In the Cooperative's first year of operation, they generated a budget of \$20,000 and hired an individual to work with them for nine months. During the second year of operation they hired the same individual for the entire year. The services and advice that this pest manager provided are listed in Table 1. Since its inception,

**Table 1. Services provided through the Wayne County Pest Management Cooperative, Inc.**

Orchard Mapping
Sprayer Calibration
Pest Management Practices
Weekly Orchard Scouting During Growing Season
Monitoring of Weather Conditions to Determine Disease Infections
Recommendations on the Need for Pesticide Applications
Chemical Thinning Recommendations
Leaf Samples/Soil Samples for Nutrient Evaluations
Harvest Evaluation for Fruit Quality Determinations
Soil pH Calculations
Crop Record Management—Applications of Materials, etc.
Pesticide Bidding
Fertilizer Bidding

the Cooperative has faced some difficult problems. It first lost the services of the pest manager who decided to pursue an advanced degree. In anticipation of his leaving, the Cooperative recruited and hired another person to work with the manager during his final season, and then moved that individual into the manager's position. The Cooperative has also faced a problem relating to the need to increase fees, the need to have the manager spend more time with the larger farms in the Cooperative, the application of more growers to join their organization, and several other issues, all of which have been resolved without a loss of membership.

### Private Consultants

When the IPM pilot program first began, there were no private consultants providing IPM services to fruit growers in New York. As the program moved into the adoption phase (1980-present), these individuals began to appear on the scene. Some of them came directly out of the intern program operated by the IPM Program. Others were consulting on soil fertility and on forestry problems and shifted some of their activity to begin consulting with fruit farmers. To date, there are four private consultants with established clientele in western New York.

### Chemical Fieldmen

The initiation of the adoption phase of the IPM effort in apples coincided to some extent with the retirement

of several chemical fieldmen. These changes offered IPM interns the opportunity to find employment with local sales organizations that emphasized service to the grower as well as pesticide purchasing. Several IPM interns are now employed as chemical fieldmen in the WNY area.

### Obstacles to Adoption

Integrated pest management on apples in New York has followed the path of development, demonstration, and adoption. The pilot program demonstrated both to Cornell, and to apple growers, that an IPM approach was practical and economical. The first two phases were rather easy to bring about compared to the effort needed to assure adoption of IPM concepts. Barriers to adoption included: the lack of extension agent understanding and thus reinforcement of IPM principles and practices, the lack of trained personnel, and organized opposition from the chemical industry. In the later case, fieldmen often tried to belittle the efforts of the IPM program through conversations with growers, and pressured aerial applicators into refusing to fly for IPM growers. Since some of them also brokered fruit, they often kept potential apple buyers away from IPM growers. Many of these obstacles gradually disappeared as educational efforts intensified and regulatory pressures increased.

### Measuring the Impact

One of the motivating forces that called for the establishment of the first Extension IPM pilot programs was the environmental movement in the United States. Throughout the course of the New York IPM effort, the Cornell IPM Program has documented the use of pesticides, the costs of crop protection, and the quality of the apples at harvest, for both IPM and non-IPM growers. Data in Figure 1 shows the use of pesticides over a 10-year period and can be divided into four distinct segments. Period 1 is not indicated in the figure but represents the time during which the development of IPM concepts by Cornell research and extension teams took place (1975 and earlier). Period 2 represents the demonstration of IPM concepts by the Cornell IPM Farm Advisors. The demonstration of IPM concepts by trained professionals led to a reduction in the use of pesticides by as much as 50 per cent, in the case of insecticides. Period 3 represents the time frame when interns, working with Cornell IPM personnel, were practicing their IPM skills by gathering information on pest activity and making recommendations to growers under the guidance of the Cornell IPM Farm Advisors. Period 4 represents the changeover to a system operated entirely by the growers. At the inception of the Wayne County Pest Management Cooperative, an IPM intern was hired to provide IPM services. This event signalled the end of formal Cornell involvement. The slight rise in grower pesticide use in Periods 3 and

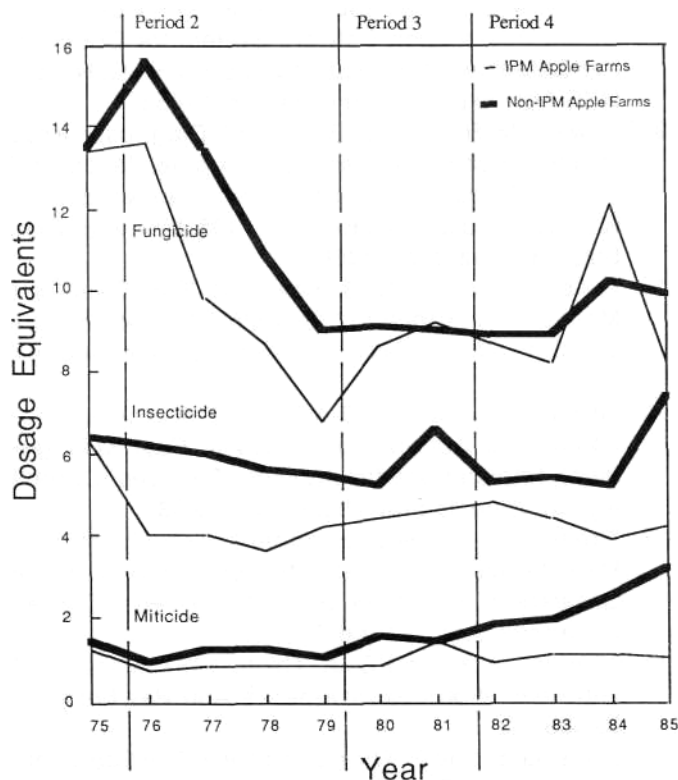


Figure 1. Pesticide use on 20 IPM apple farms and 15 non-IPM apple farms.

4 reflects the movement of IPM concepts from experienced Cornell staff to less experienced personnel (interns and IPM managers). This again emphasizes the need to provide a mechanism for training individuals who will eventually provide the IPM services. These private sector IPM practitioners will need not only experience in the use of IPM methods and technology, but must also know the industry and the expectations of growers with whom they work. Reasons for the parallel drop in pesticide use on non-IPM farms include the establishment of an IPM pest, crop, and weather network which provides information on disease infection periods, insect emergence, crop susceptibility, and rainfall. This information is collected across the fruit belt and is used in extension radio broadcasts and newsletters.

While economic data and other forms of analysis showed that growers enrolled in the pilot program or in the cooperative received many benefits, all fruit growers in western New York realized some benefits. The production of pest fact sheets, IPM manuals, and improved pest recommendations, reached all growers through the Cooperative Extension network.

### CONCLUSION

This report summarizes the Integrated Pest Management effort on Apples in New York conducted by the Cornell IPM Program and examines the movement of this effort through the stages of development, demonstration, and adoption. A second paper highlighting other aspects of our analysis (3) shows that some type of IPM knowledge and practice is employed on over 80 per cent of the apple acreage in all of New York. Furthermore, there has been a significant decrease in the use of pesticides by those who practice a total IPM approach with no significant differences in fruit quality. All of this spells increased farm profitability for those growers who employ a total IPM approach. It also indicates that the often adversarial objectives of improved environmental quality and improved farm profitability can be resolved on common ground.

The IPM approach had a planned beginning in New York and will continue to be emphasized in our approach to crop protection. It may eventually evolve into something more appropriately titled Integrated Crop Management, but the integration of disciplinary knowledge and the concepts of scouting pests and crops will remain essential. Concerns over the misuse, intensive use, and environmental impact of pesticides, which first caused Congress to appropriate USDA Smith-Lever 3d funds for demonstrations of IPM concepts, have been addressed. In New York, we have convinced our state legislature and our governor that these concepts need to be expanded and brought to all segments of the state where environmental issues and pest control approaches are in conflict. As of this writing we have initiated an apple IPM demonstration pro-

gram in the eastern New York region in response to grower and community interest, and as a result of new state funding for IPM.

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